Recorded and predicted distribution of the Golden-tipped Bat *Phoniscus papuensis* (Dobson, 1878) in Australia

D. W. Walton[1], J. R. Busby[1] and D. P. Woodside[2]

[1] Australian National Parks and Wildlife Service, G.P.O. Box 636, Canberra, ACT 2601

[2] Taronga Zoo, Mosman, NSW 2088

INTRODUCTION

Very little is known of the biology of the bats of the genus *Phoniscus*. Whether the name *Phoniscus* should be accorded generic or subgeneric status is subject to debate (Hill 1965; Koopman 1982; Mahoney and Walton 1988). *Phoniscus papuensis* is the only species recorded from Australia. Although originally proposed in the combination *Kerivoula papuensis* Dobson, 1878, there is no controversy regarding the specific status of *papuensis* (nomenclature follows Hill 1965; Hill and Smith 1985).

The genus occurs predominantly in tropical regions: Indonesia, the Philippines, Papua New Guinea and Australia. Within Australia, *Phoniscus papuensis*, thought to be a relatively recent immigrant from New Guinea, has been recorded as far south as 36°S in New South Wales. This is well south of latitudes normally regarded as tropical. Whether the non-tropical records represent the location of relict populations, are the result of special habitat requirements or seasonal migration, or are part of a distributional continuum is not known.

Phoniscus papuensis is rare in collections of Australian Chiroptera. The 11 available records, however, indicate a distribution along the eastern coast of Australia, extending from Cape York in northern Queensland to southern New South Wales near the Victorian border (Lunney and Barker, 1986). In view of the apparent rarity of the species and the paucity of data on its biology, a bioclimatic prediction system (BIOCLIM) was used to investigate the following:

1. where *P. papuensis* could be expected to occur; and
2. what climatic factors, of those investigated, define the distribution of *P. papuensis* in Australia.

MATERIALS AND METHODS

Species Localities

Eleven definable capture localities for *Phoniscus papuensis* in Australia were used. One locality, recorded only as Cape York, was too vague for use in this study. A report of the species from Cloncurry, Queensland, has been found to be in error (Lunney and Barker 1986) and, consequently, was not incorporated. The locality data are presented in Table 1.

Climate Analysis

The data were analysed by the bioclimate prediction system, BIOCLIM. This system derives site-specific climate estimates from mathematical surfaces fitted to measured meteorological data (for further details and applications see Busby 1986, 1991; Nix 1986).

Monthly mean minimum and maximum temperature estimates were derived from Australia-wide surfaces fitted to measured data from 901 meteorological stations throughout the country. Estimates of the mean true error, averaged over the data points used, are less than 0.5°C for every month of the year for both maximum and minimum temperatures.

Precipitation estimates were derived from surfaces fitted to measured data from rainfall stations for the period 1901–75 and with a minimum record of five years. Estimates of the mean true error at the data points north of 21°S are either less than 10 mm (dry season) or less than 14% of the monthly mean (wet season) for all months. Precipitation estimates for the other sites were similarly derived with errors of less than 7 mm or 10%.

Climate Profile

Monthly temperature and precipitation estimates were obtained for each site at which *Phoniscus papuensis* was recorded, as a function of latitude, longitude and elevation of that site. These estimates provided the values for 16 climate parameters (Table 2), indicative of mean, seasonal and extreme values of the species' climatic environment. For each parameter, the values from all the sites were ranked into numerical order and the minimum and maximum values determined. These, collectively, constitute the climate profile for *P. papuensis* (Table 2).

Table 1. Localities for *Phoniscus papuensis*.

Locality	Lat.	Long.	Elevation (m)
McIlwraith Range, Qld	13°57′	143°12′	200
Cooktown, Qld	15°28′	145°15′	20
Shiptons Flat, Qld	15°48′	145°16′	400
Redlynch (near Cairns), Qld	16°53′	145°41′	120
Lake Tinaroo, Atherton, Qld	17°10′	145°33′	680
Rifle Range, Atherton, Qld	17°16′	145°29′	780
Rockhampton Region, Qld	23°30′	150°30′	5
Mimosa Creek, Qld	24°35′	149°40′	140
Woolgoolga, NSW	30°07′	153°12′	20
Myall Lakes, NSW	32°26′	152°24′	10
Mumbulla State Forest (near Bega), NSW	36°44′	149°59′	20

Table 2. Climate profile for *Phoniscus papuensis* (all temperatures in °C, all precipitation quantities in mm).

Climate parameter	Minimum	Maximum
Annual mean temperature	14.7	25.7
Mean minimum temperature coolest month	3.7	18.6
Mean maximum temperature warmest month	24.3	34.1
Annual temperature range (max.-min.)	13.4	26.7
Mean temperature coolest quarter	10.2	23.1
Mean temperature warmest quarter	19.1	27.8
Mean temperature wettest quarter	19.1	27.4
Mean temperature driest quarter	10.8	24.7
Annual mean precipitation	666	1 951
Precipitation wettest month	85	468
Precipitation driest month	2	75
Coeff. variation monthly precipitation	18	121
Precipitation wettest quarter	250	1 218
Precipitation driest quarter	9	240
Precipitation coolest quarter	15	345
Precipitation warmest quarter	250	730

Predicted Distribution

The predicted distribution for *Phoniscus papuensis* was based on the similarity of climates at points on a 0.5° latitude-longitude grid of Australia to the climate profile. The climate values for each grid point were compared with the climate profile to determine if the climate was apparently suitable for *P. papuensis*. If values for all 16 parameters at the grid point fell between the minimum and maximum values for each variable of the climate profile, then the point was considered to possess a climate suitable for the species. Note that this included "marginal" sites (*sensu* Busby 1984, 1991). The latter category was not distinguished because of the limited number of data points. If values for one or more parameters fell outside that range, the climate at the grid point was considered to be unsuitable.

RESULTS

Actual capture sites and predicted distributions are presented in Figure 1. The prediction on the 0.5° Australia-wide grid indicates that climates falling within the profile of *Phoniscus papuensis* are restricted to a very narrow band down the eastern coast of Australia (Fig. 1). A detailed analysis of the climate parameters

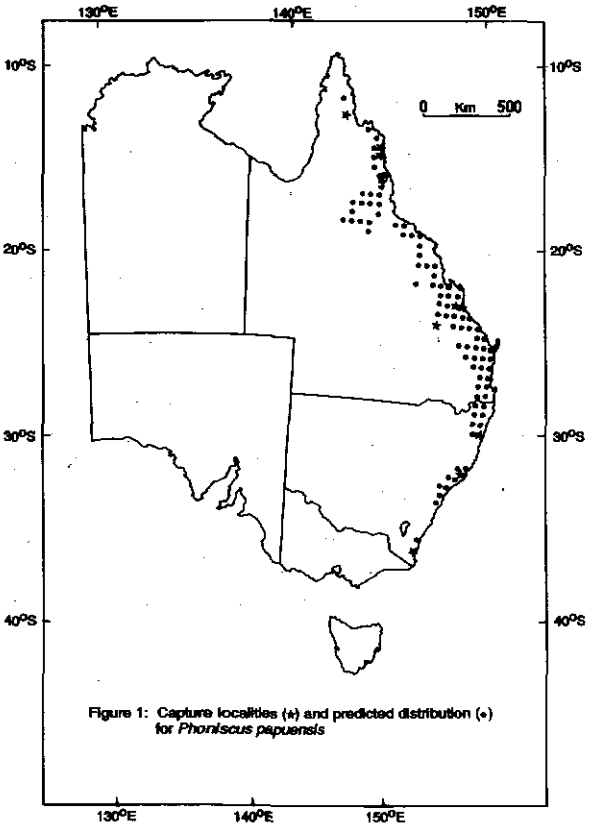

Figure 1. Capture localities (*) and predicted distribution (•) for *Phoniscus papuensis*.

correlated with this distribution shows that the species is predicted to occur in equable, high summer-rainfall conditions, i.e., those correlated with "tropical" and "subtropical" moist closed forests (rainforests) of coastal lowlands in eastern Australia.

A comparison between the climate profile of *Phoniscus papuensis* and that derived from the 2 795 points on the 0.5° Australian grid suggests that the species may be relatively indifferent to mean annual and winter temperatures and dry season (winter) precipitation. The species occurs in the upper quartile of Australian values for mean annual and wet season (summer) precipitation and has relatively low values for summer temperatures. The most significant attribute, however, is the temperature range from the mean winter minimum to the mean summer maximum, where the species probably occurs within the lowest 10% of values in the country, i.e., in very equable thermal environments.

DISCUSSION

The bioclimatic analyses indicate that *Phoniscus papuensis* is stenothermic and requires reasonably high moisture levels. It has been reported to use palm foliage as a roost in Australia and the roofs of houses in Papua New Guinea (Richards 1983). If the climate profile reflects the range of roost preferences, then a preference for roosts which are less buffered against environmental fluctuations than caves or tree hollows could well explain the apparent dependence on high moisture and a narrow temperature range. Such conditions could be a major factor in determining its distribution. This combination of climate parameters in Australia is restricted to a very narrow longitudinal, but extensive latitudinal, band down the eastern coast. This band is characterized by tropical and warm temperate type climates. These climatic conditions also support subtropical rainforest in the deep coastal valleys of eastern New South Wales and Victoria (Bridgewater 1987).

Because of the rarity of capture of *Phoniscus papuensis* in Australia, no reliable estimate of its abundance is practicable. The climate profile projected in this study is limited by the small amount of available data. Climate may not be the sole determining factor, but the prediction does provide a useful guide to future searches for this elusive bat. Suitable habitat appears to be rather limited in extent, a factor which also suggests that this small bat is highly vulnerable to habitat alteration. The climate profile presented here may provide clues to the distribution of *P. papuensis* in Papua New Guinea.

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